HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

1/26

PRESYNAPTIC NEURON
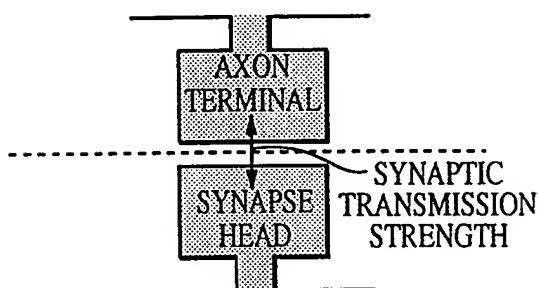
POSTSYNAPTIC NEURON

FIG. 1
PRIOR ART

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

2/26

FIG. 2
PRIOR ART

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

3/26

$[Ca^{2+}]$

PLASTICITY MOVES TOWARD LTP	4
MOVEMENTS TOWARD LTP/LTD CANCEL OUT	3
PLASTICITY MOVES TOWARD LTD	2
NO CHANGE	1
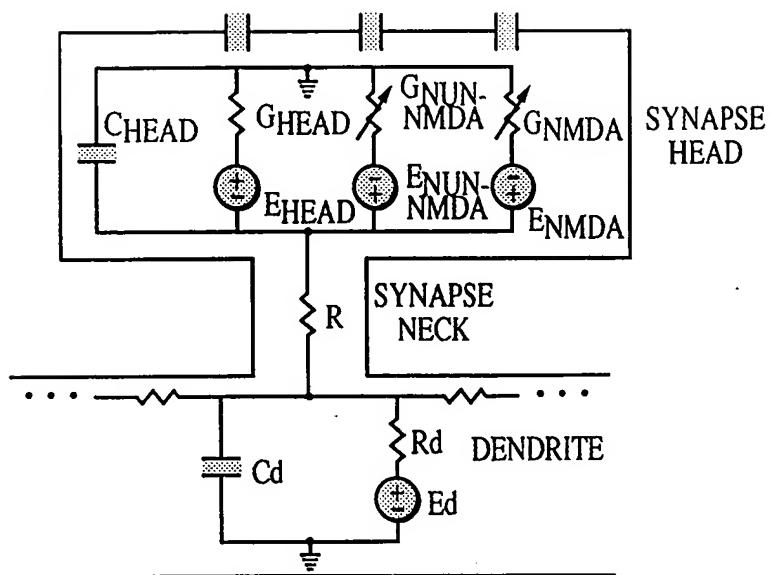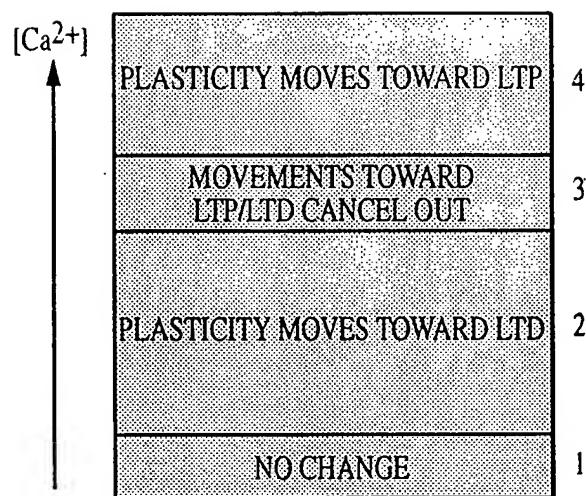
FIG. 3
PRIOR ART

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

4/26
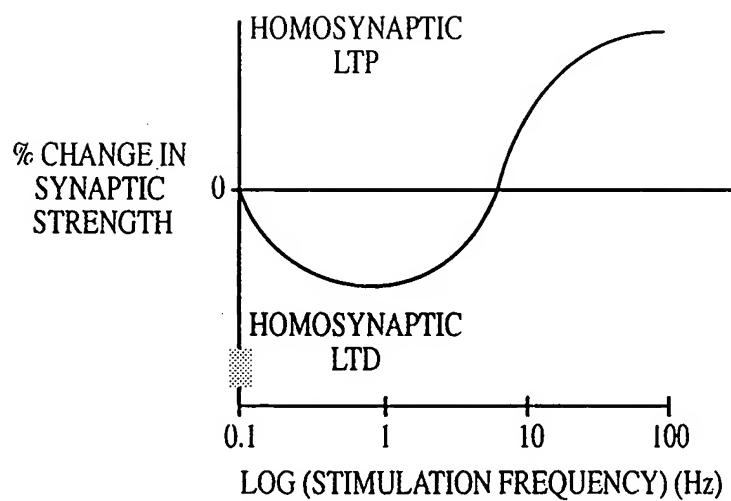
FIG. 4
PRIOR ART

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

5/26

20 SYNAPSE CIRCUIT

THRESHOLD DETECTION CIRCUIT — 22

SIGNAL CONVERSION AND FORMATTING CIRCUIT — 24

STORAGE DEVICE — 26
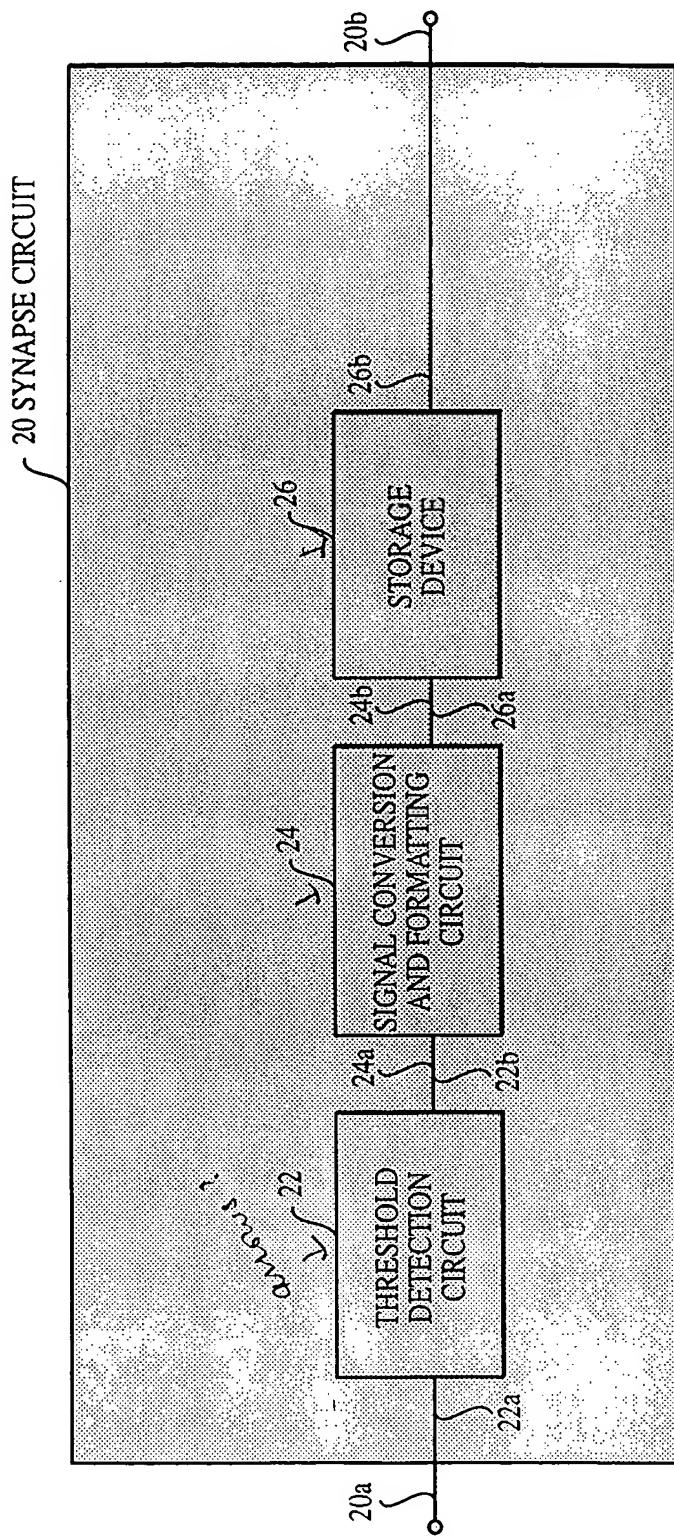
FIG. 5

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

6/26

20 SYNAPSE CIRCUIT

20a

21a
32 STORAGE ELEMENT

21b
34 NON-NMDA RECEPTOR CHANNEL

21c
36 NMDA RECEPTOR CHANNEL

20b
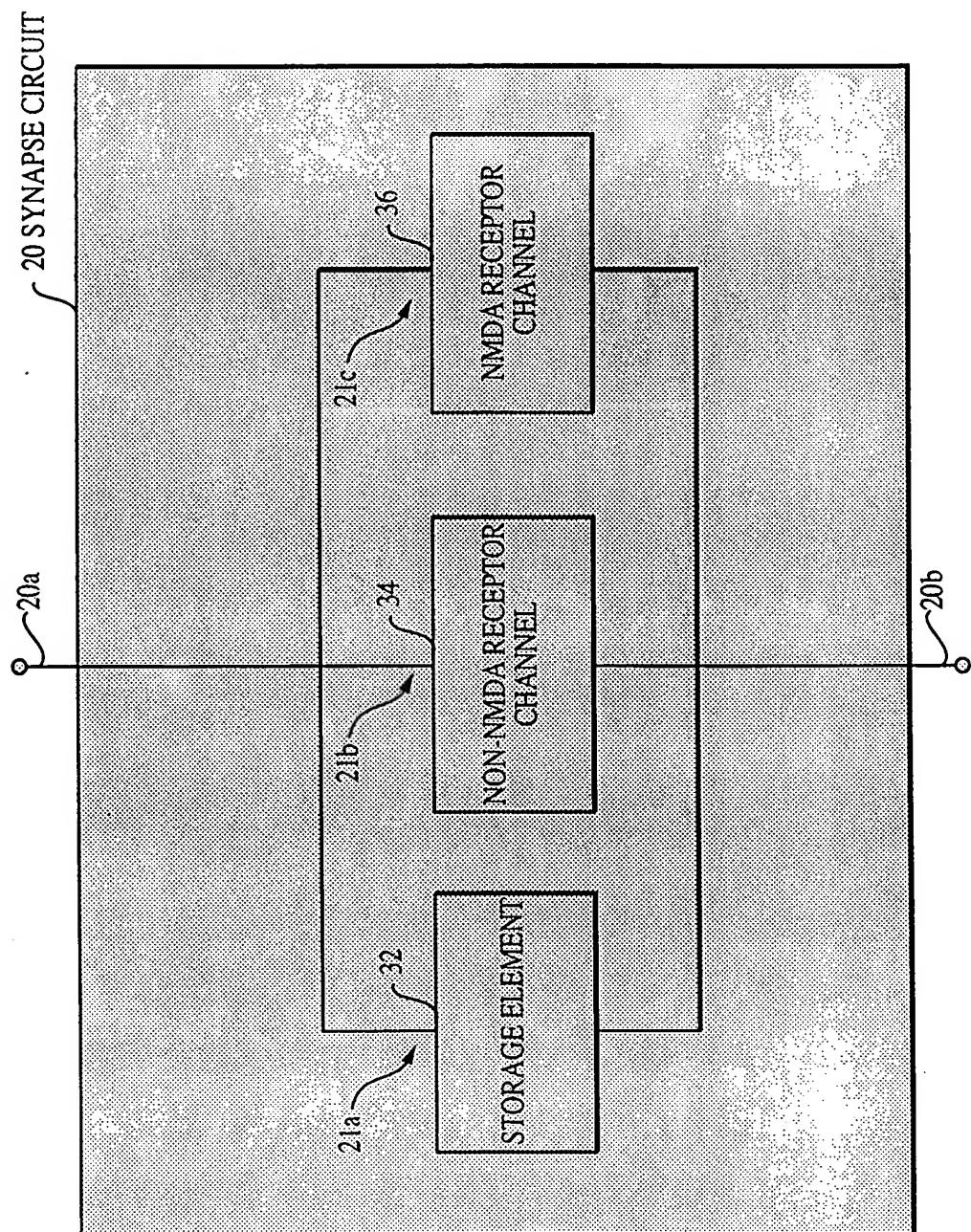
FIG. 6

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

7/26
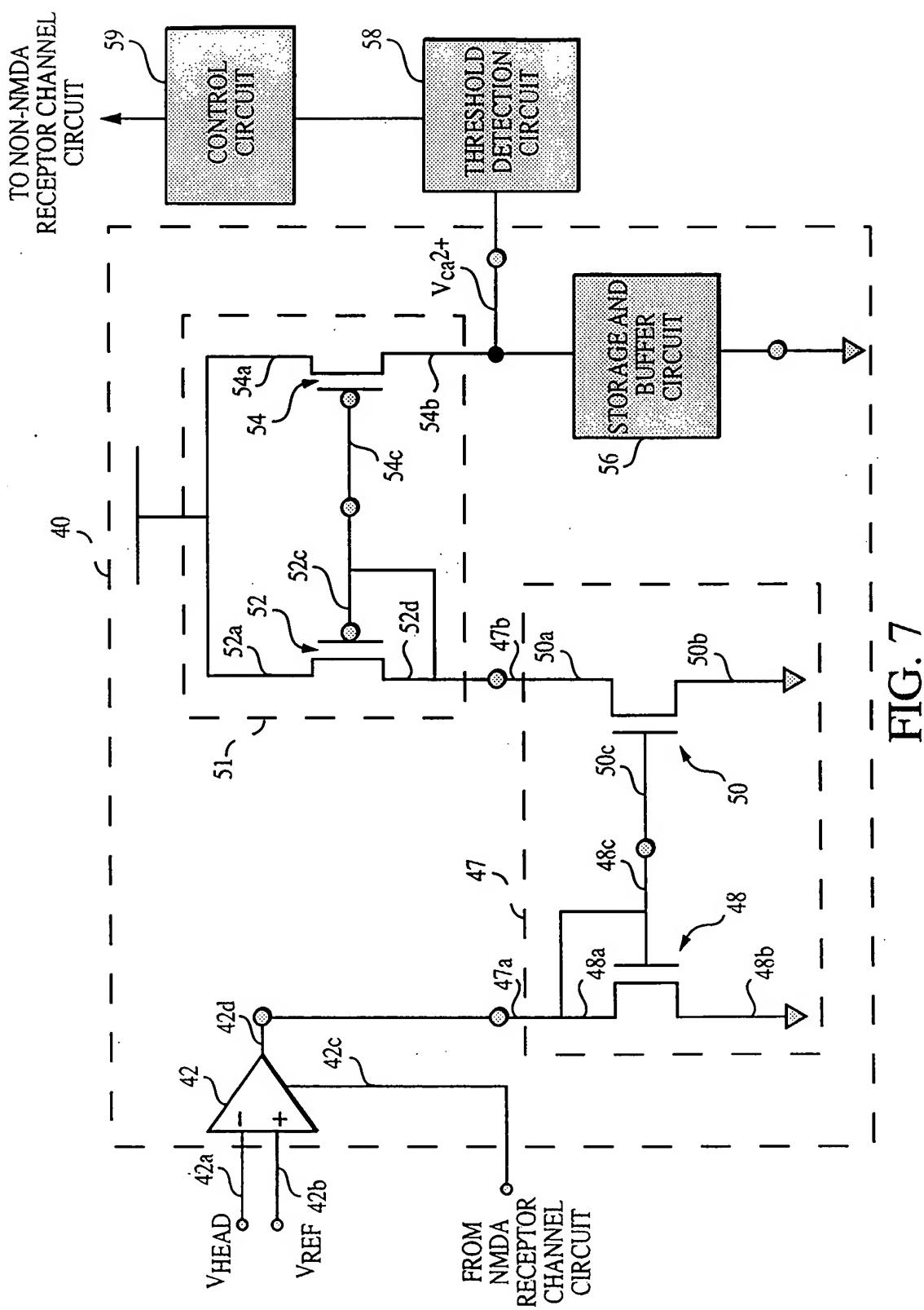
FIG. 7

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

8/26
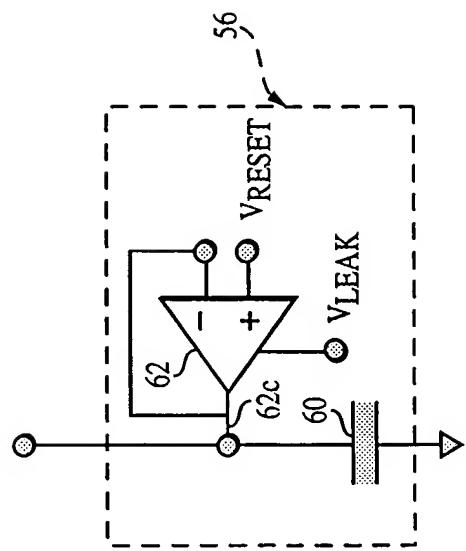
FIG. 8

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

9/26
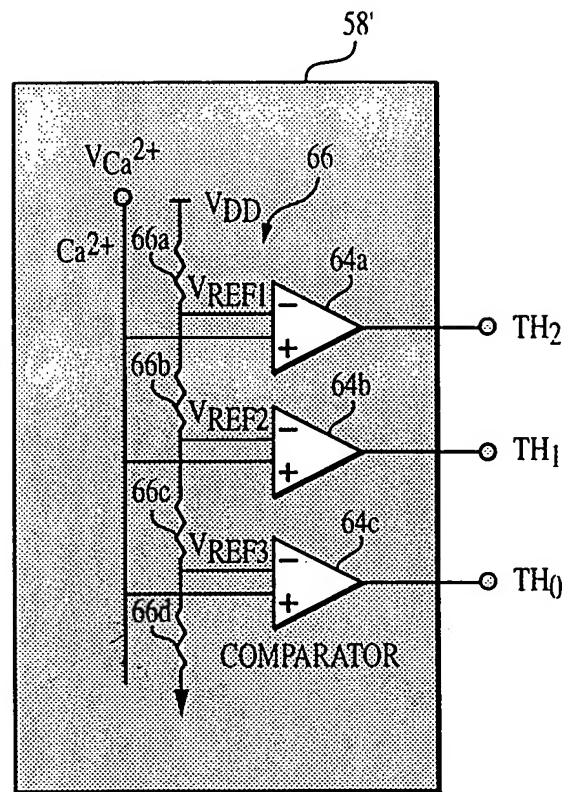
FIG. 9

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

10/26
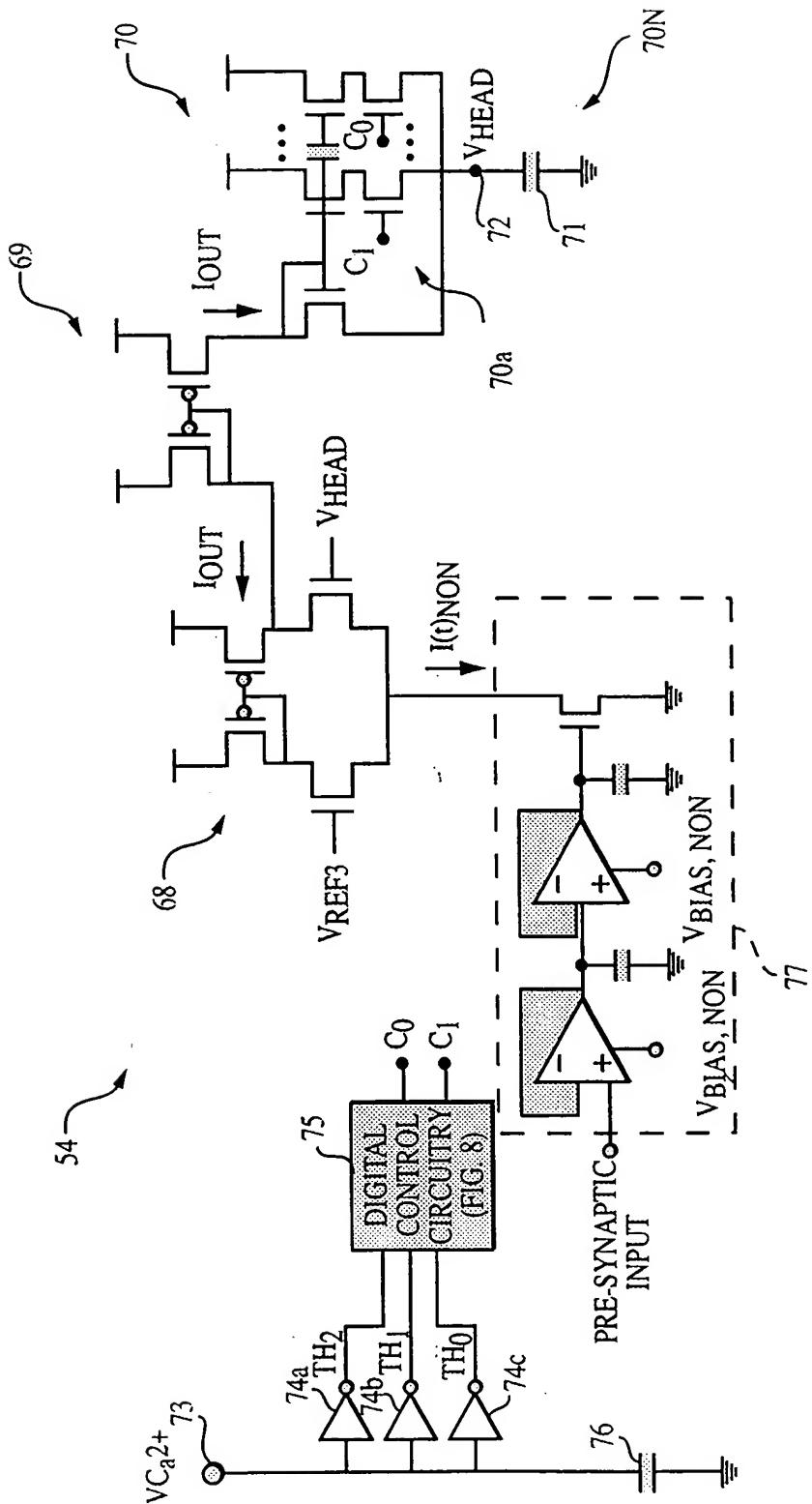
FIG. 10

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

11/26
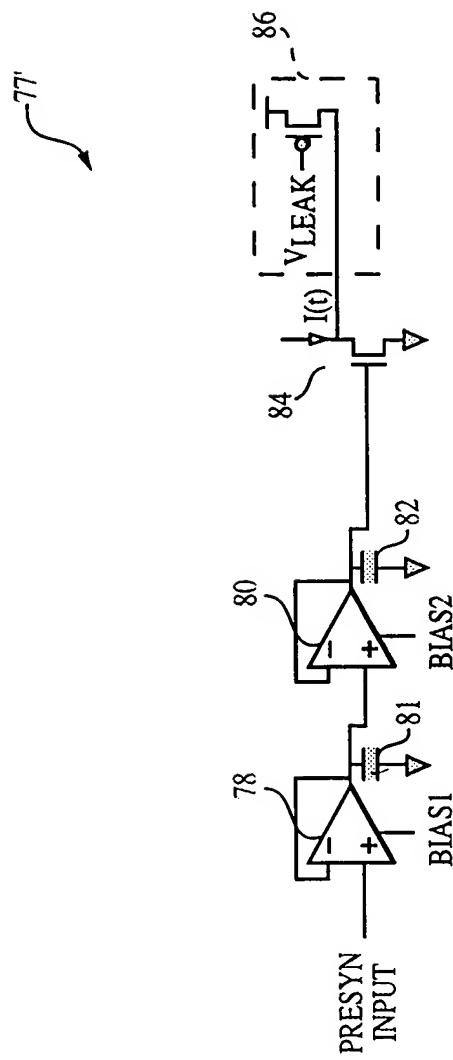
FIG. 10A

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

12/26

I_{REF}

$I(t)$

$-77''$

C_N C_O

FIG. 10B

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

13/26

NMDA CURRENT IN RESPONSE TO ONE PRESYNAPTIC STIMULUS
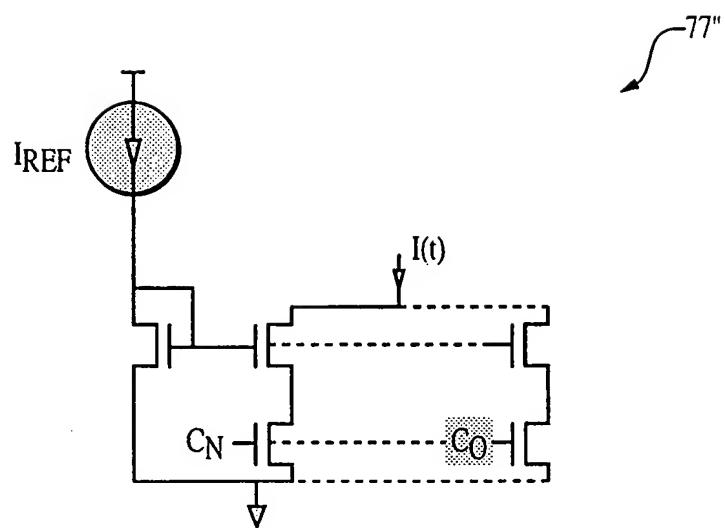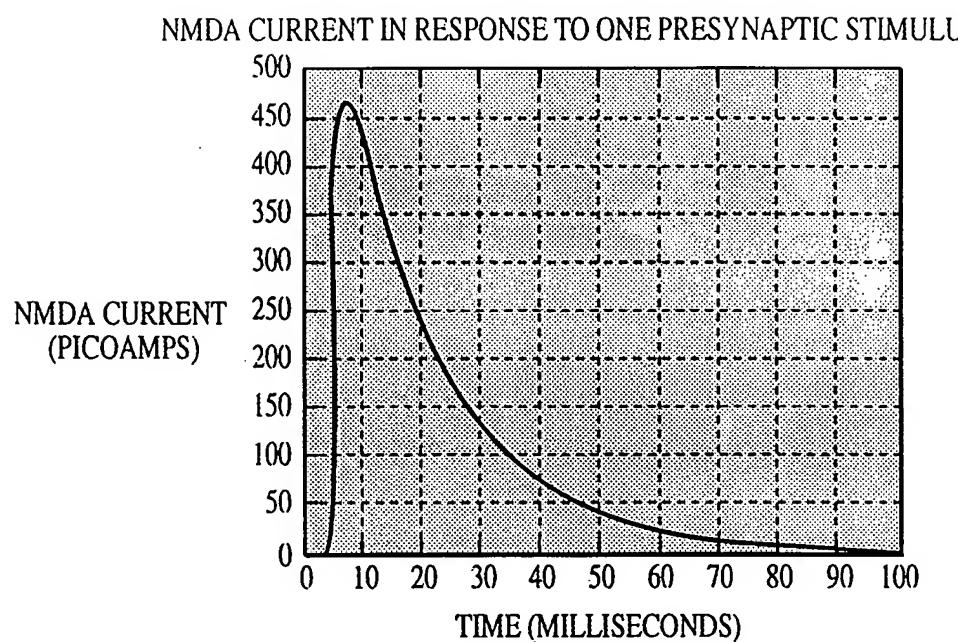
FIG. 10C

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

14/26

PRESYNAPTIC
INPUT

CM1

$V_{REF\,t}$

$V_{REF\,z}$

CM2

V_{ALPHA}
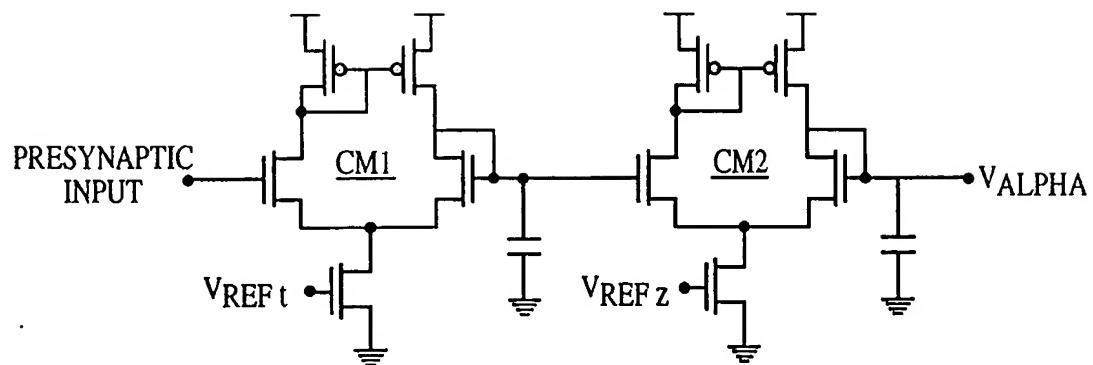
FIG. 10D

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

15/26
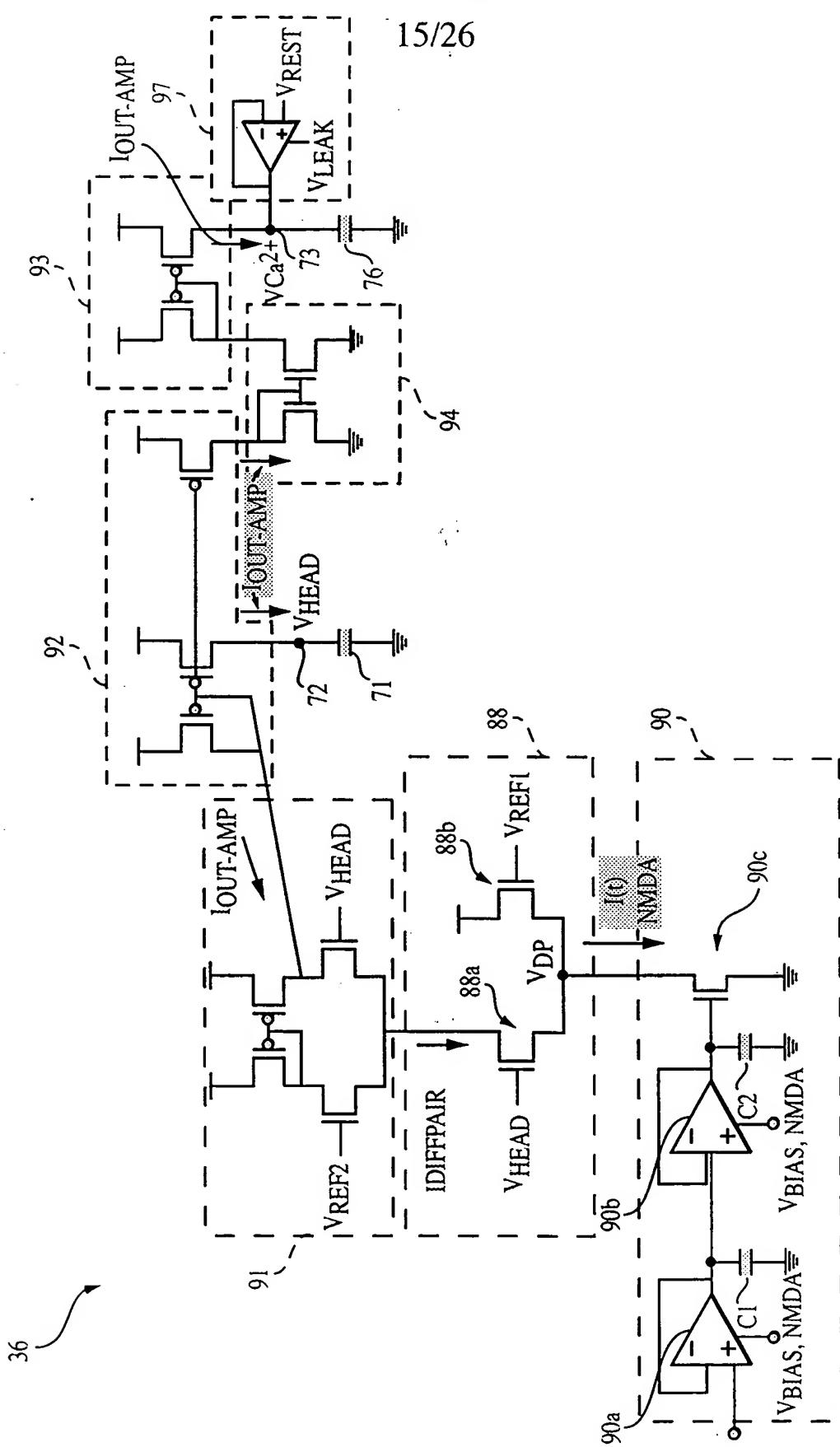
FIG. 11

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

16/26

NON-NMDA CURRENT
(PICOAMPS)

TIME (MILLISECONDS)

FIG. 11A

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

17/26
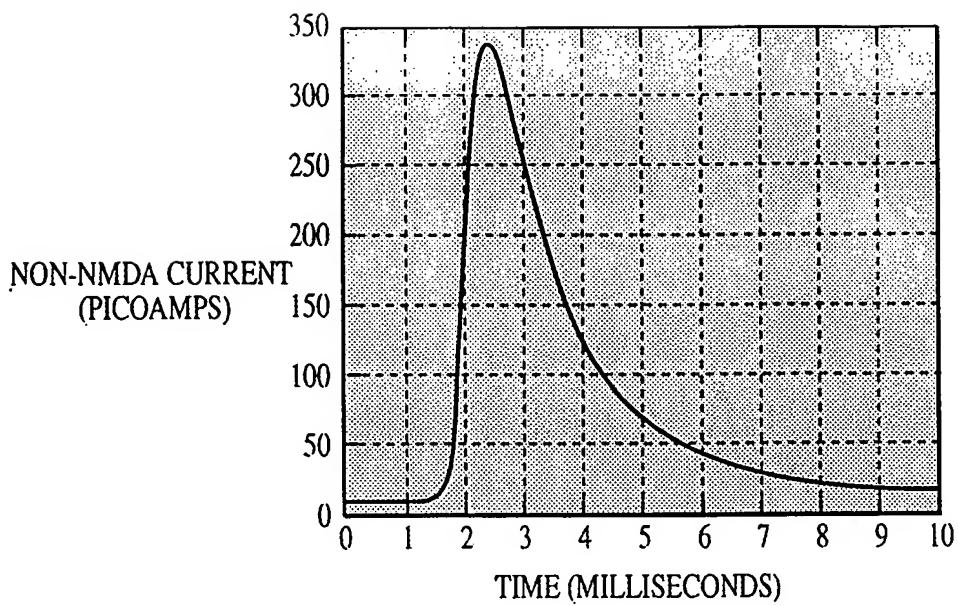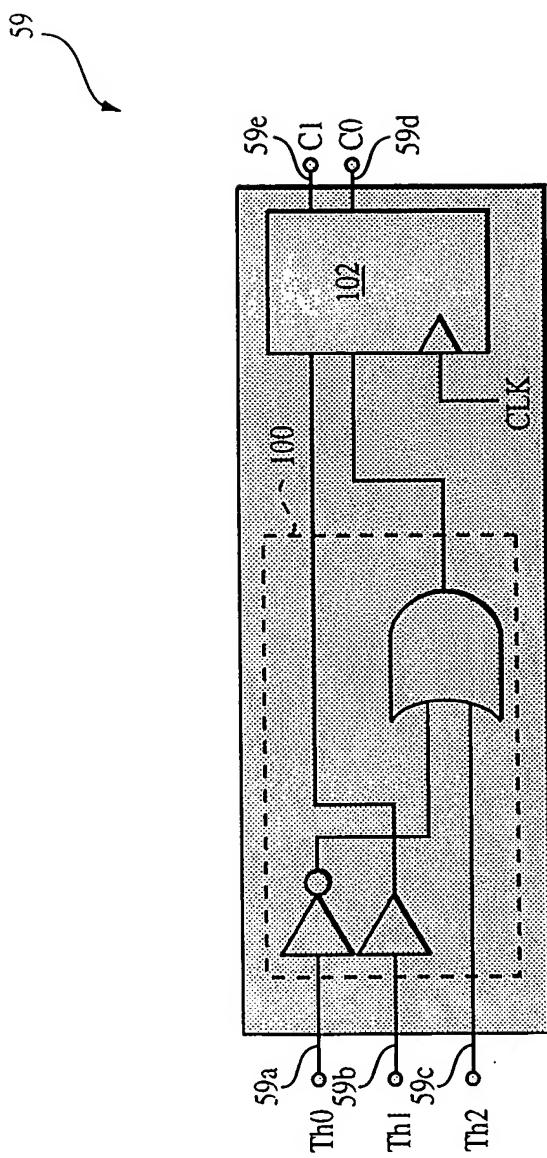
FIG. 12

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

18/26
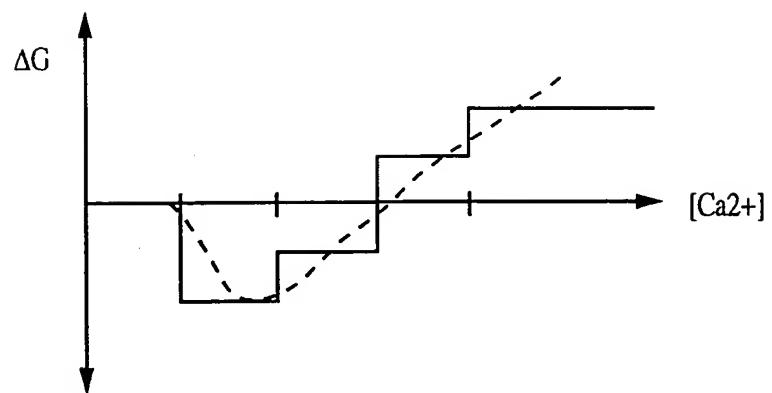
FIG. 13
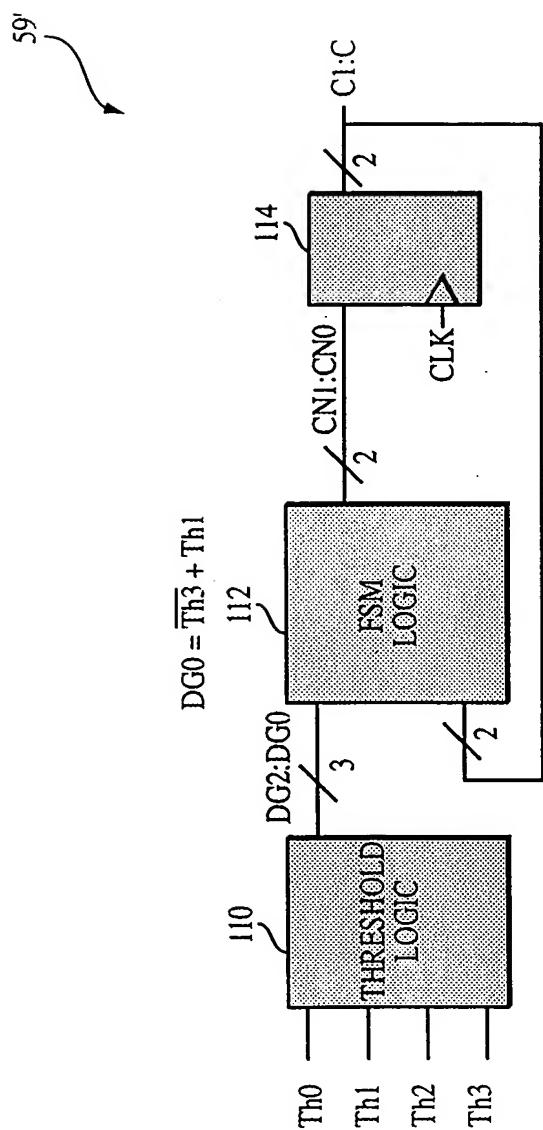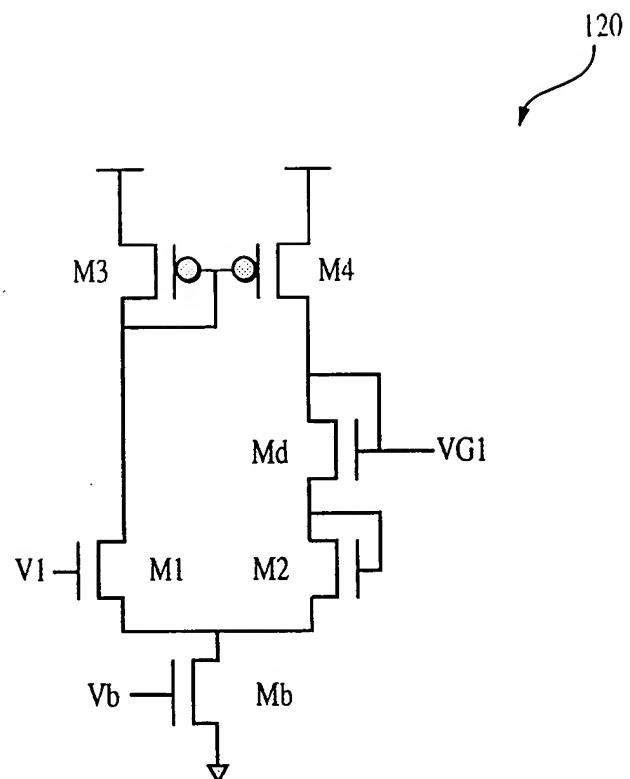
HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

19/26

FIG. 13A

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

20/26

120

FIG. 14

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

21/26

FIG. 14A

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

22/26

FIG. 15

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

23/26

FIG. 15A

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

24/26

FIG. 15B

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

25/26

FIG. 16

HEBBIAN SYNAPSE CIRCUIT
Louis Nervegna et al.
MIT-046CUS

26/26

FIG. 17